PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : B41F 5/06 — A1

(11) International Publication Number: WO 95/31333

(43) International Publication Date: 23 November 1995 (23.11.95)

(21) International Application Number: PCT/US95/06273

(22) International Filing Date: 12 May 1995 (12.05.95)

(30) Priority Data:
08/242,475 13 May 1994 (13.05.94) US

(71) Applicant: ADVANCED VISION TECHNOLOGY LTD. [IL/IL]; 16 Galgalei Haplada, P.O. Box 12511, 46120 Herzlia (IL).

(71)(72) Applicant and Inventor: GOLDSTEIN, Michael, D. [US/IL]; 76 King David Street, 46661 Herzlia Pituach (IL).

(74) Agent: FRIEDMAN, Mark, M.; c/o Sheinbein, Robert, 2940 Birch Tree Lane, Silver Spring, MD 20906 (US).

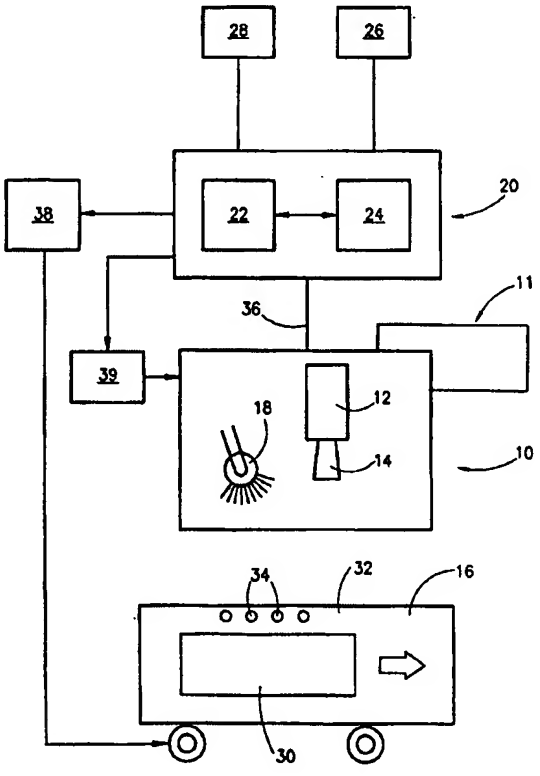
(81) Designated States: JP, KR, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: GENERAL CONTROL FOR MULTIPLE COLOR PRESS DEVICES

(57) Abstract

This invention is a system and method for monitoring the quality of color printing on a substrate of a color printing press. The system includes a sensor (12), such as a CCD color video camera, for acquiring a color image of at least one portion of the substrate, and a processor for transforming each color image into a number of separate images based on color. The processor (24) then matches each of the several separated images to corresponding reference images of the portion of the substrate through template matching to provide information regarding mis-registration, and/or to directly correct the mis-registration through suitable control mechanisms.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	**GB**	United Kingdom	**MR**	Mauritania
AU	Australia	**GE**	Georgia	**MW**	Malawi
BB	Barbados	**GN**	Guinea	**NE**	Niger
BE	Belgium	**GR**	Greece	**NL**	Netherlands
BF	Burkina Faso	**HU**	Hungary	**NO**	Norway
BG	Bulgaria	**IE**	Ireland	**NZ**	New Zealand
BJ	Benin	**IT**	Italy	**PL**	Poland
BR	Brazil	**JP**	Japan	**PT**	Portugal
BY	Belarus	**KE**	Kenya	**RO**	Romania
CA	Canada	**KG**	Kyrgystan	**RU**	Russian Federation
CF	Central African Republic	**KP**	Democratic People's Republic of Korea	**SD**	Sudan
CG	Congo			**SE**	Sweden
CH	Switzerland	**KR**	Republic of Korea	**SI**	Slovenia
CI	Côte d'Ivoire	**KZ**	Kazakhstan	**SK**	Slovakia
CM	Cameroon	**LI**	Liechtenstein	**SN**	Senegal
CN	China	**LK**	Sri Lanka	**TD**	Chad
CS	Czechoslovakia	**LU**	Luxembourg	**TG**	Togo
CZ	Czech Republic	**LV**	Latvia	**TJ**	Tajikistan
DE	Germany	**MC**	Monaco	**TT**	Trinidad and Tobago
DK	Denmark	**MD**	Republic of Moldova	**UA**	Ukraine
ES	Spain	**MG**	Madagascar	**US**	United States of America
FI	Finland	**ML**	Mali	**UZ**	Uzbekistan
FR	France	**MN**	Mongolia	**VN**	Viet Nam
GA	Gabon				

GENERAL CONTROL FOR MULTIPLE COLOR PRESS DEVICES

FIELD AND BACKGROUND OF THE INVENTION

The present invention relates to a color printing machines and, more particularly, to systems for monitoring and controlling the quality, such as the color and other attributes, and most especially the registration, of such color printing machines.

Conventional color printing machines, whether of the offset (conventional or digital), gravure, flexo types, whether of the sheet-fed or continuous web variety, as well as digital color photocopiers, typically operate by successively imposing different colors onto the substrate. The various colors combine visually to give the final product which may include subtle color shifts and various shades.

An essential requirement for the proper operation of a color press machines is that each individual color be kept register with the other impressed colors, so that each color is imposed at precisely the correct location relative to the other colors.

Register control is typically effected either manually by adjusting machine settings after observing several initial samples of the press or by using special reference marks positioned, typically in the margins of the substrate. Typically, each mark is of a pre-defined geometrical configuration and is printed using one of the press colors. The marks are typically arranged on a longitudinal line and are equally spaced so they can be readily separated by the human operator or by an automatic register control systems.

Automatic register control systems typically use an optical sensor which determines the existence or non-existence of each of the marks and which determines their locations while the press is running. The relative displacement of the marks is calculated. Correction signals are then generated and are sent to the appropriate mechanical means, which vary for the various press types. The mechanical means are then adjusted to

compensate for the deviations. Such methods are used in most of the known press technologies including, but not limited to, offset, gravure or flexo printing processes, and is useful for both sheet-fed and continuous web printing, as well as in digital offset presses and digital color photocopiers.

Various attempts have been made to offer systems for identifying the different marks and providing correction signals. For example, U.S. Patent No. 3,653,322 discloses the use of rectangular marks for detection by sensors. EP 123,305 uses triangular marks which assist in interpretation of not only longitudinal deviation but lateral too. PCT application WO 86/05141 suggests taking a two-dimensional image of a cluster of register marks and comparing those to a reference image representing a correct registration marks layout. The above-referenced publications are incorporated by reference as if fully set forth herein.

The presently known techniques suffer from a number of disadvantages. First, typically register control system can operate only after images are already in rough register (typically within 5 mm). Yet, at beginning of a press run, during the initialization of the press (known as the makeready phase) or following an abrupt substrate speed change, which may occur, for instance, after a reel change in web presses, color register deviations may be greater and so human operator intervention is needed.

Second, most machines are able to handle longitudinal or at the most longitudinal and lateral register detection and correction. However, additional problems such as skew or rotational misregister and stretching, are encountered, especially in sheet-fed presses or digital photocopiers, or in web presses using very wide substrates.

Finally, and most importantly, currently known techniques require the use of a set of special marks which are printed on the special margins of the imprinted substrate forcing waste of material. These margins must

subsequently be cut and discarded, resulting in additional operation and in the wastage of a significant portion of the substrate.

There is thus a widely recognized need for, and it would be highly advantageous to have, a system for monitoring and controlling the quality, especially the registration, of a printing press machine which would avoid the shortcomings of presently available systems.

SUMMARY OF THE INVENTION

According to the present invention, there is provided a system for monitoring the quality of color printing, using multiple printing stages, on a substrate of a color printing press, comprising: (a) a sensor for acquiring a color image of at least one portion of the substrate; (b) means for transforming the color image into a plurality of separate images, each of the separate images being related to one of the printing stages; and (c) means for matching each of the plurality of separate images to corresponding reference images of the portion of the substrate.

According to the present invention, the quality of color printing may be the register quality, the color quality or the non-color and non-register quality, encompassing such miscellaneous defects as hickeys, hazing, streaks, known in the industry as doctor streaks, and the like.

Also according to the present invention, there is provided a method for monitoring quality of color printing, using multiple printing stages, on a substrate of a color printing press, comprising the steps of: (a) acquiring a color image of at least one portion of the substrate; (b) transforming the color image into a plurality of separate images, each of the separate images being related to one of the printing stages; and (c) matching each of the plurality of separate images to corresponding reference images of ti portion of the substrate.

According to further features in preferred embodiments of the invention described below, the system includes a display for showing the

results of the matching and/or includes a control system for automatically adjusting the printing press.

According to still further features in the described preferred embodiments the portion of the substrate being monitored is a portion of the image being printed.

The present invention successfully addresses the shortcomings of the presently known configurations by providing a system which is based on image processing and color transformation.

The method involves acquiring a two-dimensional image on-line, on-press from the currently printed substrate, of a part of the impressed image content, performing analysis of the image itself, by executing digital color transformation, interpreting the plurality of the single channel color images, analyzing their relative deviation and providing the correction signals or alarms.

Various embodiments of systems according to the present invention are able to detect and correct misregister and make it possible to view the registration of the imprinted material.

Systems according to the present invention provide a faster and more accurate method for putting the press machine in register. The enhanced dynamic range of operation allows even at least part of the makeready phase to be regulated.

Systems according to the present invention are able to make register corrections in the longitudinal, lateral and rotational directions and to provide warning signals related register quality. In certain systems, automatic correction is provided.

Systems according to the present invention eliminate the need for special margins of the substrate dedicated to register control marks.

In printing systems where the images are digitally formed or generated, stored images can be used as a reference for the imprinting process control and process quality. Preferably, the digitally originated

images provide the a priori register pre-set and register tolerance and a priori color and other quality parameters.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is herein described, by way of example only, with reference to the accompanying drawings, wherein:

FIG. 1 is a schematic view of the physical components of a system according to the present invention;

FIG. 2 schematically depicts the operation of a system according to the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is of a system which can be used to monitor the operation of a color printing press machine, particularly the registration of the machine and other quality parameters such as color variations and the existing of various other defects, and either provide information, such as alarms and/or displays and/or feedback control inputs, regarding misregistration to the operators or automatically correct misregistrations.

The principles and operation of a system according to the present invention may be better understood with reference to the drawings and the accompanying description.

Referring now to the drawings, Figure 1 illustrates some of the basic components of a typical system according to the present invention. The system includes two major components -- an optical head and a processor.

The optical head is located over the substrate being printed in such a way that images can be taken of the printed material.

An optical head, designated generally as **10** includes a two-dimensional sensor **12** providing a reflectivity readout for different channels of the reflected spectrum. Sensor **12** can be, but is not limited to, a suitable color CCD video camera, such as, for example, Model DXC-930

manufactured by SONY of Japan. Any other suitable one-dimensional or two-dimensional sensor device may be used. A one-dimensional sensor can be employed by using the longitudinal movement of the substrate together with the lateral data in the sensor to form a two-dimensional image from the press.

Sensor **12** may be a fixed focal lens camera. Preferably includes a zoom lens **14** to allow sensor **12** to view a printed substrate **16** at various magnifications. Also includes is suitable means for lighting substrate **16**, which may be, but is not limited to, flash light, continuous light, sensors with shutters, and the like, preferably a strobe light **18**.

A system according to the present invention also includes a control unit **20** which is preferably equipped with an image frame grabber/buffer **22**, an image processor **24**, a screen **26**, which can serve to display results of the processing, and a control panel **28**.

Synchronization of a system according to the present invention to the press or repeat phase can be effected using any of a number of known techniques, such as synchronization to the press machinery by shaft encoders, proximity sensors, rotating wheel attached to the moving substrate, and the like.

Optical head **10** may be located inside the press machine, near its end or at a more remote location. Optical head **10** can be fixed in a specific position but is preferably mounted on a motorized traverse bridge **11** which makes it possible for optical head **10** move transversely, i.e., substantially perpendicular to the direction of movement of substrate **16**.

A system according to the present invention may be used with conventional printed marks in the margins. Preferably, a system according to the present invention is used without the use of such printed marks by viewing portions of the product being printed itself, rather than by viewing register marks in the margins, thereby obviating the need for providing margins around the printed product. The elimination of the margins results

in highly significant savings in the amount of substrate required to carry out a specific printing job.

Optical head **10** is mounted so that any part of the printed area, image area **30** or any side marks, as well as the margins **32** bearing register marks **34**, of substrate **16** can be viewed.

Images are preferably acquired into sensor **12**, typically a camera, with the help of illumination by, for example, strobe light **18**, or various other means of freezing images of the moving substrate, with duration which is preferably in the range of one micro second to ensure that the acquired image is not blurred even when the system is used to monitor high speed presses operating at speeds of 20 meters/second or more.

Zoom lens **14** can be used for selecting different levels of sensitivity. The acquired image, in either analog or digital form, is passed to the control unit **20** by a suitable communication means **36**.

Control unit **20** may be located near the press or connected to the sensor itself, preferably near the press operator table. Control unit **20** preferably includes a frame grabber **22** which holds the acquired image, and a dedicated image processor **24** for image analysis. Various image processors are available commercially, for example from DataCube Inc. of Massachusetts, U.S.A. Control unit **20** is also preferably equipped with a display for providing operator interface and for displaying the acquired images.

Control unit **20** is connected to a control panel or similar user interface through which commands can be entered. Control unit **20** is optionally connected to a signal driving box **38** which drives the correcting signals to the mechanical means for register correction in the press. Control unit **20** can be connected to a suitable warning or alarm device (not shown) which can alert the operator of misregister problems.

The processing of the image is sufficiently fast that an image from each repeat, or cycle, of the press can be acquired and analyzed. The

result of misregister can be used as part of a feed-back loop to automatically control the press or to provide an alarm for an operator so that correction measures can be manually executed.

In certain applications, especially, but not limited to, wide web printing, two or more heads can be placed on the two lateral sides of the web, and/or at the front and back of the substrate, so that higher accuracy of web distortion or skew can be detected.

The processing carried out in the image processor **24** is described below with reference to Figure 2.

The first step involves the acquisition **40** of the image from the press. The color image taken from the press is typically acquired in a multiple of color channels images, for example in a color space known as RGB (red, green, blue) or in other color spaces such as YUV, HSI, YIQ, and the like. These multiple color channel images are digitized and then stored in the frame buffer.

The digitized RGB images next undergo digital color transformation **42**. Digital color transformation is effected using information from each of the separate color channels of the image and serves to transform the input color channels images to digital images in the color space of the inks used in the specific press, i.e., colors which represent, or are related to, the separate ink imposing stages in the press system in question. For example, as is shown in Figure 2, the RGB colors are transformed into C, M, Y, K channels, designated as **44**, **46**, **48** and **50**, respectively. Thus, the present invention calls for the separation of the color image into a plurality of separate images based on color, i.e., separation into colors which are, or which are related to, the colors imposed on the substrate by the various stages of the printing process.

These transformations can be effected using well known techniques, for example, the techniques described in Joblaue, G.H. and Greenberg, D., "Color Spaces for Computer Graphics", Computer Graphics, Vol. 12, No.

3, August 1978, which is incorporated by reference as if fully set forth herein. The transformations can be readily carried out using commercially available hardware. The result of the transformations are separate digital color channels images, wherein each color channel image corresponds to each of the different impression stages of the press machine.

The next step is the separate matching of each color channel, designated **52**, **54**, **56** and **58** for the C, M, Y, K channels, respectively. After obtaining the separated digital images, each of the images is matched with the corresponding separate digital images of a reference image **68**, designated **60**, **62**, **64** and **66** for the C, M, Y, K channels, respectively, which is to described later. Preferably, the user is able to select the tolerance of detection or correction. Reference image **68** also undergoes a transforation **70** similar to that described above.

The result of each matching is a displacement vector $\mathbf{D}_{color}$ in the sensor coordinate system, representing the relative displacement between the separate band of the acquired image and the corresponding separated band of the reference image.

Techniques for aligning two monochrome images are well known to those skilled in the art of signal processing and are sometimes referred to as template matching or correlation. A good description can be found in "Computer Image Processing and Recognition" by E.L. Hall, Academic Press. A technique such as the one described in the Hall book, or other techniques, can be carried out separately for each of the separate colors.

It should be noted that if the content of any of the single channel color images is a two-dimensional monotone function such as a flat homogeneous color area, the result of the matching is not single-valued. Hence, special care should be taken in selecting the reference image to ensure that the inspected portion of the image on the substrate is not monotonic.

In the case that the single band color images are monotonic functions the press operator can locate different locations which contain images which are not monotonic. Alternatively, the offered system can search automatically for locations on the press that contain non-monotonic information. Searching for non-monotonic image locations can make use of the motorized traverse bridge. For this purpose, a sensor controller **39** can be used to translate information from control unit **20** to commands for moving optical head **10** to a suitable location.

Alternatively, a method according to the present invention can be applied to a digital pre-press systems which can indicate the suitable locations for acquiring satisfactory images for registration control.

In any case, the press operator or the creator of the pre-press digital image can intervene and suggest a preferred location for the process to take place or the tolerances to be used.

The next step in processing the information involves the calculation of the register deviation **72**. The quality of registration or the amount by which each color stage deviates from original intended location is calculated by subtracting $\mathbf{D}_i$ from $\mathbf{D}_{zero}$, resulting in $\mathbf{D'}_i$, where $\mathbf{D}_{zero}$ typically, but not necessarily, represents the first color printed, which is commonly black.

In certain applications, such as sheet-fed presses or reel-to-product, $\mathbf{D}_{zero}$ can be subtracted from the Zero coordinate frame of the sensor in order to provide print-to-cut register control.

Finally, the net displacement vector, $\mathbf{D'}_{color}$, can be displayed on an output device **74**, such as display screen which allows the operator to manually adjust the sensitivity for each deviation separately, and/or can be used to drive a suitable mechanical means, such as dancing rollers, and the like, to effect registration corrections and can, in addition, display color images on a suitable display screen.

Reference image **68** is selected and acquired in any convenient way. For example, reference image **68** may be acquired after the press has started to operate and a satisfactory register quality has been attained. The image then undergoes digitization and transforation **70**.

Another option is to use a previously obtained "hard copy" model image of the press as the reference image. The image may be a proof, i.e., a hard copy sample of the job to be printed relative to which the printing job will be evaluated, or a high quality example of previous runs.

Yet another possibility, which is applicable to digital or other presses, is to use original digital image of the press as the reference.

Finally, the original digital image of the press can be used in the form of separated color bands suitable for the matching process.

Although methods according to the present invention are capable of using portions of the image itself for registration monitoring and control, the color separation and processing described herein may also be used, if desired, with printed register marks. The process of color transformation and matching is done in a way which is entirely similar to that described above but using the printed register marks rather than portions of the image itself. A method according to the present invention may thus be used with any set of marks, whether the marks are part of the image or are any of a variety of marks especially printed on the margins of the substrate. The separation analysis can be carried out on any part of the impressed image, including but not limited register marks, folding marks, color patches marks, and various parts the impressed image.

A system according to the present invention provides the ability to monitor and correct both transverse and longitudinal misregister. In addition, rotational and stretching misregisters can also be detected and corrected whenever two optical heads are used, one on each side of the substrate.

The field of view of a system according to the present invention is such that very large misregisters can be viewed, detected and corrected. This feature makes it possible to greatly reduce waste during the makeready phase.

The register analysis can be made on a cluster, rather than using separate sensors for each color. Using clusters is most beneficial where the system is space-constrained and there is no practical location for locating sensors (such as sheet-fed machines).

While the invention has been described with respect to a limited number of embodiments, it will be appreciated that many variations, modifications and other applications of the invention may be made.

WHAT IS CLAIMED IS:

1. A system for monitoring the quality of color printing, using multiple printing stages, on a substrate of a color printing press, comprising:

(a) a sensor for acquiring a color image of at least one portion of the substrate;

(b) means for transforming said color image into a plurality of separate images, each of said separate images being related to one of the printing stages; and

(c) means for matching each of said plurality of separate images to corresponding reference images of said portion of the substrate.

2. A system as in claim 1, further comprising:

(d) means for displaying at least a portion of said color image.

3. A system as in claim 1, further comprising:

(d) means for displaying at least a portion of at least one of said plurality of separate images.

4. A system as in claim 1, further comprising:

(d) means for controlling the printing press based on the results of said matching of said separate images to said corresponding reference images.

5. A system as in claim 1, wherein said sensor is a color video camera.

6. A system as in claim 5, wherein said color video camera is a CCD camera.

7. A system as in claim 1, wherein said means for transforming transforms said color image from the RGB color space system to a second color space system.

8. A system as in claim 1, wherein said means for transforming transforms said color image from the RGB color space system to the CMYK color space system.

9. A system as in claim 1, further comprising:

(d) means for selecting said at least one portion of the substrate.

10. A system as in claim 1, wherein said at least one portion of the substrate is a portion of the product being printed.

11. A system as in claim 1, wherein said at least one portion of the substrate is on the margins of the image being printed.

12. A system as in claim 11, wherein said at least one portion of the substrate includes special register marks.

13. A system as in claim 1, further comprising:

(d) means for zooming said sensor.

14. A system as in claim 1, further comprising:

(d) means for laterally moving said sensor.

15. A system as in claim 1, further comprising:

(d) means for illuminating said at least one portion of the substrate.

16. A system as in claim 15, wherein said means for illuminating is a strobe.

17. A system as in claim 1, wherein said reference image is a proof.

18. A system as in claim 1, wherein said reference image is a digital image.

19. A system as in claim 1, wherein said means for matching includes template matching.

20. A system for monitoring the color quality of color printing, using multiple printing stages, on a substrate of a color printing press, comprising:

(a) a sensor for acquiring a color image of at least one portion of the substrate;

(b) means for transforming said color image into a plurality of separate images, each of said separate images being related to one of the printing stages; and

(c) means for matching each of said plurality of separate images to corresponding reference images of said portion of the substrate.

21. A system for monitoring the register quality of color printing, using multiple printing stages, on a substrate of a color printing press, comprising:

(a) a sensor for acquiring a color image of at least one portion of the substrate;

(b) means for transforming said color image into a plurality of separate images, each of said separate images being related to one of the printing stages; and

(c) means for matching each of said plurality of separate images to corresponding reference images of said portion of the substrate.

22. A system for monitoring the general non-color and non-register quality of color printing, using multiple printing stages, on a substrate of a color printing press, comprising:

(a) a sensor for acquiring a color image of at least one portion of the substrate;

(b) means for transforming said color image into a plurality of separate images, each of said separate images being related to one of the printing stages; and

(c) means for matching each of said plurality of separate images to corresponding reference images of said portion of the substrate.

23. A method for monitoring quality of color printing, using multiple printing stages, on a substrate of a color printing press, comprising the steps of:

(a) acquiring a color image of at least one portion of the substrate;

(b) transforming said color image into a plurality of separate images, each of said separate images being related to one of the printing stages; and

(c) matching each of said plurality of separate images to corresponding reference images of said portion of the substrate.

24. A method for monitoring the color quality of color printing, using multiple printing stages, on a substrate of a color printing press, comprising the steps of:

(a) acquiring a color image of at least one portion of the substrate;

(b) transforming said color image into a plurality of separate images, each of said separate images being related to one of the printing stages; and

(c) matching each of said plurality of separate images to corresponding reference images of said portion of the substrate.

25. A method for monitoring the register quality of color printing, using multiple printing stages, on a substrate of a color printing press, comprising the steps of:

(a) acquiring a color image of at least one portion of the substrate;

(b) transforming said color image into a plurality of separate images, each of said separate images being related to one of the printing stages; and

(c) matching each of said plurality of separate images to corresponding reference images of said portion of the substrate.

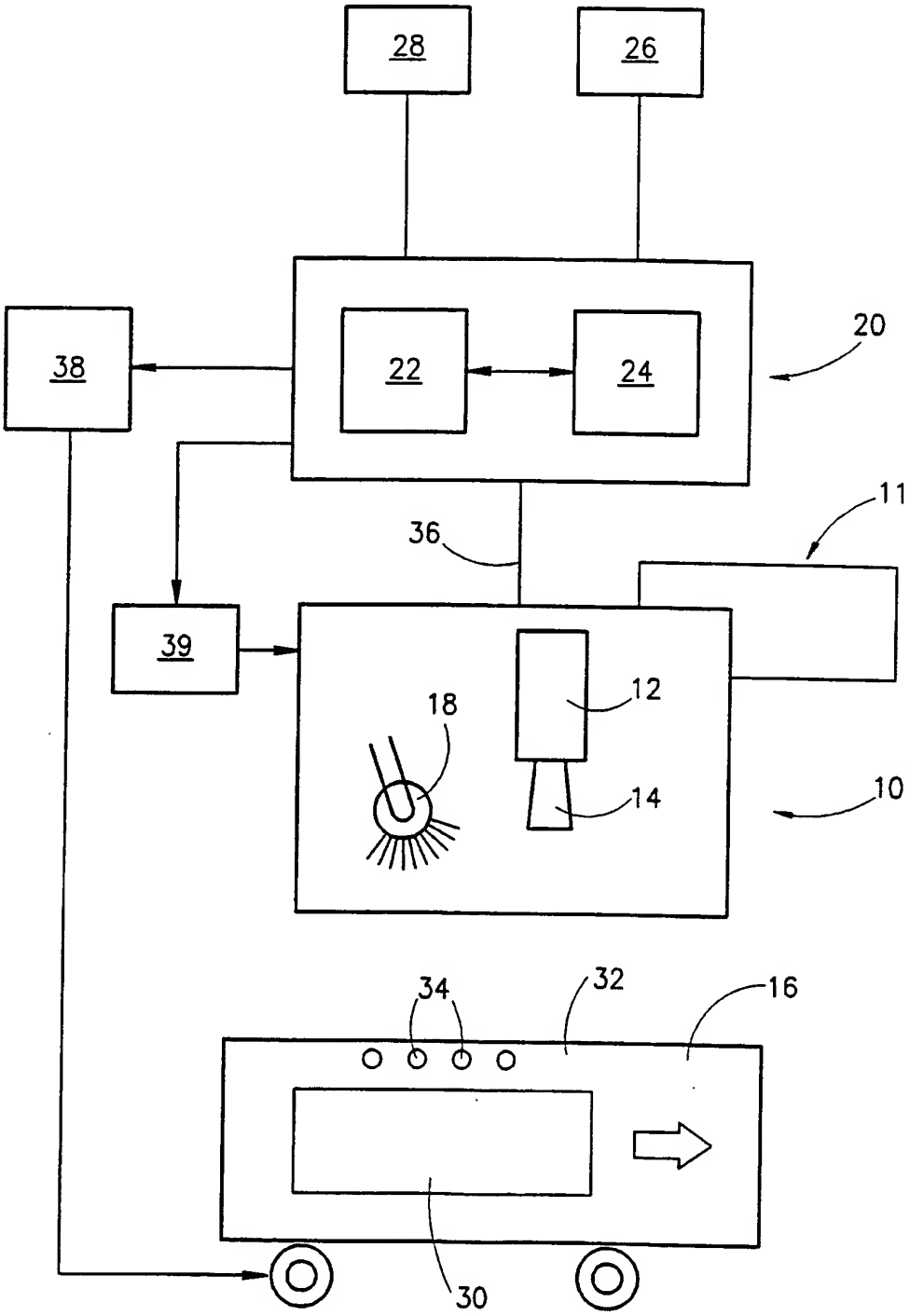


FIG. 1

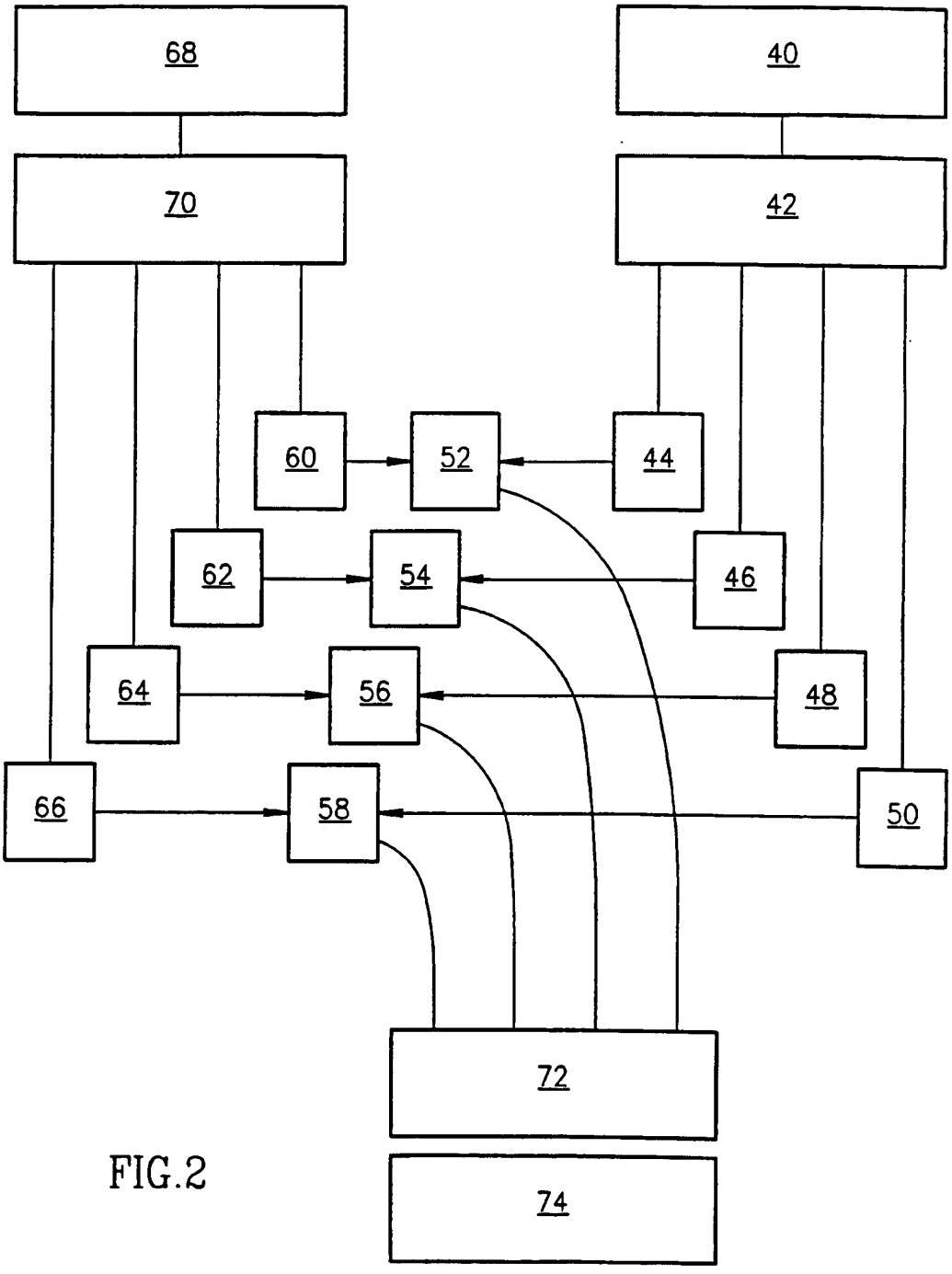


FIG.2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/06273

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B41F 5/06
US CL :101/181, 211

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 101/181, 211 248, DIG. 36; 250/559, 561; 356/429

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X, Y	US, A, 5,018,213, (SIKES), 21 May 1991. See column 7, lines 23-62.	1-25

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 20 JULY 1995	Date of mailing of the international search report 31 JUL 1995
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer FOR JOHN R. FISHER Telephone No. (703) 308-0525

Form PCT/ISA/210 (second sheet)(July 1992)*